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ANATOMICAL REPORT ON THE BRAIN OF A BOLIVIAN INDIAN, WITH A STUDY OF CORTICAL THICKNESS.

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THE individual from whom this brain was removed was a full-blooded Indian, born in Bolivia, age 30 years, height 6 feet 7 inches, and weight over 300 pounds. He was a case of acromegaly and full details of his history were given in this JOURNAL for Nov., 1893.

I have hoped that a careful study of the convolutional development of this brain might have some anatomical and anthropological interest. So far, little has been accomplished in the attempts to make out sexual, intellectual, moral, or racial distinctions in the brains of men. But the study is still in its infancy and more has been done and more can be expected by investigating racial characters than in the other directions. While these notes may not of themselves have absolute value, they may in the future prove helpful in connection with the observations of others.

The weight of the brain was 53 oz, the brain being thoroughly dry, and freed from the dura.

The shape of the brain was conformable to its mesocephalic skull, the cephalic index of which was 73. There were no peculiarities or deformations that would strike one at first glance except a deep vertical indentation running up and down the tip of the right occipital lobe, and this, as Bastian has shown, is not very rare. The total length from frontal to occipital pole was 18.7 ctm., its breadth 13.5 ($7\frac{3}{8}$x$5\frac{1}{4}$ in.).[1]

Fissuration.—The fissures are, on the whole, rather clearly marked and the convolutional development a simple one. There is, however, this peculiarity: The fissures are cut into by numerous short off shoots or clefts, due to sharp angular changes in the course of the fissure. This is shown in the photographs, but not at all well. The fissure of Rolando has eight of these clefts on the right side, five on the left. In other brains, I find only three or four. The Sylvian fissures have five and nine, the temporal and parietal nine to eleven of these short clefts. It gives the brain a peculiar highly fissured appearance.

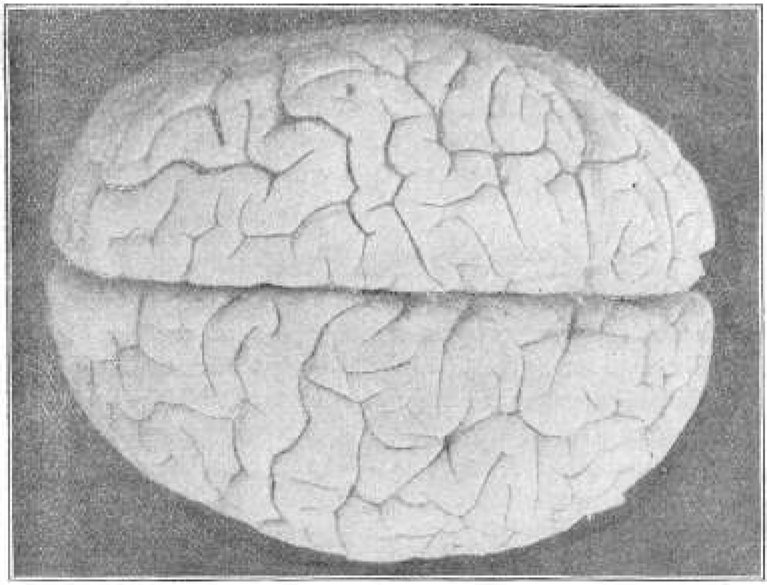

FIG. I.

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[1] The average range (Krause) is, length 16.2–17.2, breadth 12.3–14.2, height 10.2–10.8.

General course.—The brain has many transverse markings, such as Bastian affirms to be characteristic of the Mongolian brain. The Indian, in my opinion, belongs to that race. On the left cerebral hemisphere I note ten and on the right eight fissures running nearly transversely (see below). The angle formed by the fissures of Rolando is very obtuse (75°); the detailed description of these I give below.

Confluence.—There is a somewhat excessive confluence of fissures. Thus the fissure of Sylvius on the left side has four confluences, on the right, one.

Fissure of Rolando	3 and 1	respectively.
Parieto-occipital	1 and 1	
Inter-parietal	1 and 2	
First temporal	2 and 2	
Second "	2	
Third "	2 and 1	
Fourth "	2	

Of these, the confluences of the Sylvian fissuers and of the parieto-occipital are rare.[2]

Continuity.—The *right inter-parietal* fissure is broken in three parts; the left is continuous.

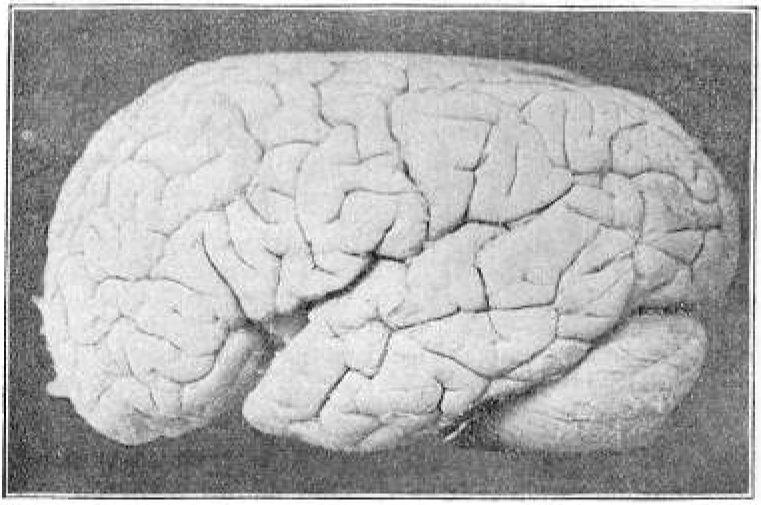

Fig. II. Left Hemisphere.

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[2] The rich fissuration of the medi-frontal, said by Benedickt to be found in criminal brains, is not noticeable here.

I have seen this fissure broken in three parts on each side in the brain of a negress, and it, perhaps, indicates a low type.

The *left first temporal* has a separate ascending branch.

The *left second temporal* is broken in four parts, as often occurs; the right is continuous, and this is unusual.

The *left third temporal* has three parts, the right two parts.

The fourth temporals are continuous.

The *right sub-frontal* (calloso marginal) is composed of three parts, as is not very rarely the case; the left is continuous.

On the whole, it cannot be said that the fissures are excessively broken.

Length of fissures.—The Sylvian fissure is longer on the left side, as is the rule, and is longer than the average, 9.5 left and 8 ctm. right, as compared with the average of 8.5 and 7.28 (Eberstaller). The posterior ascending branch is also longer than the average (3 and 3.2 as compared with 2.2 and 2.4).

The great length of this fissure and its connection with the first temporal is thought to be an evidence of retroversion, as it suggests the anthropoid type (Eberstaller).

The *fissure of Rolando* is longer than the average, being 12 for the left and 11.5 ctm. for the right side, as against an average for males of 11.3 (Eberstaller). The fissures represent the absolute length as measured by a moistened thread. This unusual length may be in relation with the great muscular mass of the individual.

Position of fissures and size of frontal and occipital lobes. The portion of the fissures of Rolando is of especial interest. The distance from the trigonum to the upper end of the fissure is 22.5 ctm., from the trigonum to the occipital pole 35 ctm. The average figures are 22 and 33.6 for males (Eberstaller). According to this, therefore, the fissure of Rolando is relatively further forward than the average, and the frontal lobe, judged by this, is *relatively small.* The angle made by the fissure with the longitudinal fissure is 75°. This shows it to be unusually obtuse; most authorities make the angle 67° (Wilder), Eberstaller makes it 71° to 75°.

The *parieto-occipital fissure* is 7.3 ctm. from the occipital pole, while the distance from the frontal to the occipital

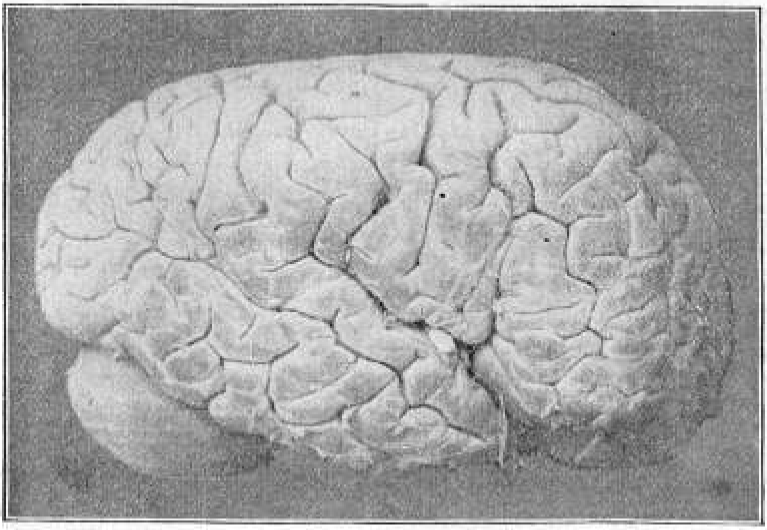

FIG. III. RIGHT HEMISPHERE.

poles is 27 left and 30 ctm. right. This makes the occipital arc 25% of the total. The ratio given by Cunningham is 21 to 100. Hence I conclude that the *occipital lobe is relatively large.*

The distance from the trigonum to the parieto-occipital fissure is 27. The ratio of the occipital arc to the total arc is 1 to 5. The average ratio is 1 to 6 (Eberstaller). This, again, shows that the occipital lobe is large.

The *Island of Reil* on the left side is exposed and its convolutions are large. This is, perhaps, connected with a large development of the corpus striatum. The fissures on the lobes show nothing notable, except that they are few. I count only two deep straight fissures on the left and three on the right.

The *uncinate* gyri on both sides are very large. The left has three shallow fissures, the right, one.

The gyri measure 2.75 ctm. in width at the widest point. This suggests a large development of the centres for smell. The *olfactory lobes*, however, seem of about the normal size.

DETAILS—The measurements are in centimetres and were made, so far as fissures are concerned, with a

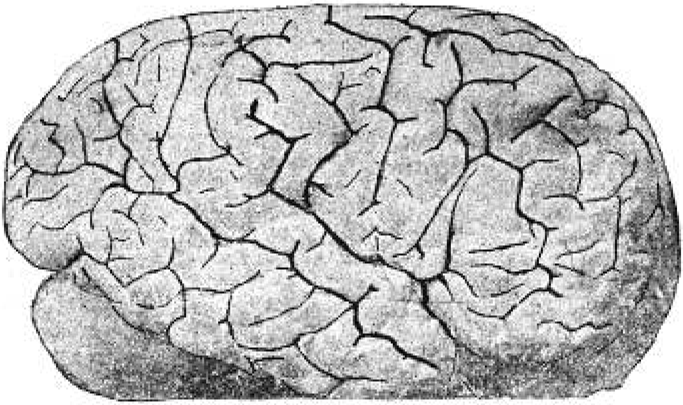

FIG. IV. BASE OF BRAIN.

moistened thread so that they represent the absolute length.

Fissure of Sylvius.

LEFT HEMISPHERE.		RIGHT HEMISPHERE.	
Length from ascending branch to posterior ascending branch	6	Length from ascending branch to posterior ascending branch	5
Posterior ascending branch	3	Posterior ascending branch	3
Total length	9	Total length	8
Anterior ascending branch	3	Anterior ascending branch	3.2
Anterior branch	2.2	Anterior branch	1.75
Fossa	1.7	Fossa	2
Depth of fissure	2	Depth of fissure	2
Communications with post central, first temporal, inferior occipital, ascending branch of first temporal.		Communication with post-central.	
An operculum exists at junction of inferior occipital, ascending branch of first temporal and lateral occipital.			
The Island of Reil is exposed.		The Island of Reil is covered.	
Temporal, anterior and ascending branches are of the Y type.		Y type.	

Fissure of Rolando.—The angle formed by the fissure with the median line was 71° for the upper third, 75° for the line drawn from upper end to lower end.

LEFT HEMISPHERE.	RIGHT HEMISPHERE.
Total length. 12	Total length. 11.5
From frontal pole to upper end of F. R 15	From frontal pole to upper end of F. R. 16
From upper end to occipital pole. 12	From upper end to occipital pole 14
Confluences with superior post-central, inferior prae-central, inferior post-central.	Confluences with tertiary fissures in superior parietal lobule.
Depth 2	Depth. 2.3
No bridges.	Same.
	A transverse inferior fissure is present.
Number of short clefts . . 5	Number of short clefts . . 8
Width of prae-central, convolutions from. . . . . . 2 to 2.7	Width of prae-central convolutions from . . . . . . 2 to 2.5

Parieto-Occipital Fissure.

LEFT SIDE.	RIGHT SIDE.
Length of external part. . . . 7.5	Length of external part. 7
Distance from trigonum. . . . 27.7	Distance from trigonum 27
Median part is long and straight	External part runs into ascending branch of temporal (anterior occipital of Wernicke).
It communicates by a deep fissure with the collateral fissure (T^4).	

The length of the occipital arc is to that whole distance from occipital pole to trigonum as one to five; Eberstaller gives it as one to six, hence the occipital lobe is larger.

Calcarine Fissure.

LEFT SIDE.	RIGHT SIDE.
Is unbroken and extends around end of occipital lobe.	Unbroken, extends around to a vertical fissure on posterior end of occipital lobe. This lies at the bottom of a deep depression 4 ctm. long. This indentation has been described by Bastian, and is due to pressure of the longitudinal sinus.

Inter-parietal Fissure.

LEFT SIDE.	RIGHT SIDE.
Continuous. Confluent anteriorly with fissure of Sylvius. The anterior occipital branch (Eberstaller) is very short. The fissure runs over into occipital lobe without apparent break, but on cutting down I find, as I have always done, a shallow bridge.[3]	Composed of three parts: a superior post-central, inferior post-central and parietal. The last or posterior division runs into the occipital lobe without a break and with no deep bridging gyrus that can be seen. It is confluent with the first temporal.

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[3] My observations in over 40 hemispheres quite agree with those of Wilder as to the anatomical character of the paroccipital fissure. It is always separated from the inter-parietal.

First, second and middle Frontal Fissures.—These are well defined with a good many tertiary fissures running into them.

Sub-frontal (Calloso-marginal).

LEFT SIDE	RIGHT SIDE.
This is continuous and typical.	Broken in three parts—anterior, middle and posterior.

First Temporal Fissure.

LEFT SIDE.	RIGHT SIDE.
Confluent with fissure of Sylvius and second temporal. The posterior ascending branch (anterior occipital of Wernicke) is *separate*.	An unbroken fissure. The posterior ascending branch is confluent with the interparietal in two places.

Second Temporal.

LEFT SIDE.	RIGHT SIDE.
Broken in four portions. It is confluent with fissure of Sylvius and first temporal.	Is unbroken and runs back into occipital lobe—a rare condition.

Third Temporal.

LEFT SIDE.	RIGHT SIDE.
In three parts. Confluent with third temporal and mental part of parieto-occipital.	Continuous. No confluences.

Corpus Callosum.

Length, 8.5.
Thickness in centre .65.
At anterior end (knee) 1 1.
At posterior end 1.3.

The average thickness given by Krause is, in centre .6, at the knee .9, at the posterior end 1.4.

Crus.

Height of crusta, left .6, right .6.

Height of crus at level of anterior corpora quadrigemina, left 3, right 3.

Weights of Different Parts and Ratios.

The brain with pia weighed 53 ounces.
Cerebral hemispheres 47.1 oz.
Pons and medulla 7.8 drachms.
Cerebellum 5.0 oz.
The two hemispheres weighed practically the same.
Ratio of cerebellum to cerebrum 10.6%.
Of cerebellum to rest of brain is 10 4%.
Huschka makes it as 13 to 87, or about 15%.

According to this, the cerebellum is very small. Meynert's figures, however, give the ratio of cerebellum to entire brain as 148 to 1383 (10.7%). Pflegers and Wechselbaum's figures are 148 to 1373, which gives about the same ratio.

I conclude that this case does not support the view that large men have disproportionately large cerebellums.

The pons and medulla, however, are relatively large, weighing 31.2 grammes, as against 22.83 (Meynert's average).[4]

Thickness of the cortex.

Much, I believe, can be learned from studies of this subject, and hence I have devoted a good deal of time to careful measurements.

These measurements were made after the brain had been hardened in bichromate and alcohol, so that it had lost one-tenth in length and one-sixth in weight.

Donaldson states that 2% should be added to the measurements made of brains hardened in alcohol. He also states that 4% should be added to measurements made with compasses.

I made one series of sixty measurements from blocks taken from the centre of the convexity of the gyri. I believe that for practical and comparative purposes this is altogether the best way.

Donaldson recommends taking three measurements from each gyrus, one from the centre and one from each side about two-thirds down. A lateral measurement is doubled, added to the convexity measurement and the total divided by three. This gives the average for the gyrus.

I made a second series of over sixty measurements by this method. The averages were reduced somewhat, but I do not think the results were so accurate. The variations in thickness of the side of a gyrus are very great and depend much upon the cutting.

The figures that I adopt finally were averages from the two sets of measurements. If one add 6 per cent. to them, they can be fairly compared with the measure ments made by Donaldson.

Leaving out the insula, *the average thickness of the*

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[4] Bischoff gives the relative cerebellar weight for Germans, 12.9% for males, and 12.8% for females; French brains 12.8%. Krause gives the cerebellar weight as 169, and total weight 1461 (males). This gives a ratio of 11.5%.

cortex was 2.92 mm., which is exactly the normal as given by Donaldson. The six brains studied by Donaldson, however, were presumably of the lower, pauper-hospital class. The thickness of the cortex, therefore, must be considered about the average of that found in the uneducated classes at least. If I add the figures for the insula it brings the average up to 3.03 mm.

The thickness of the cortex in the different lobes of the brain is shown in the following tables:

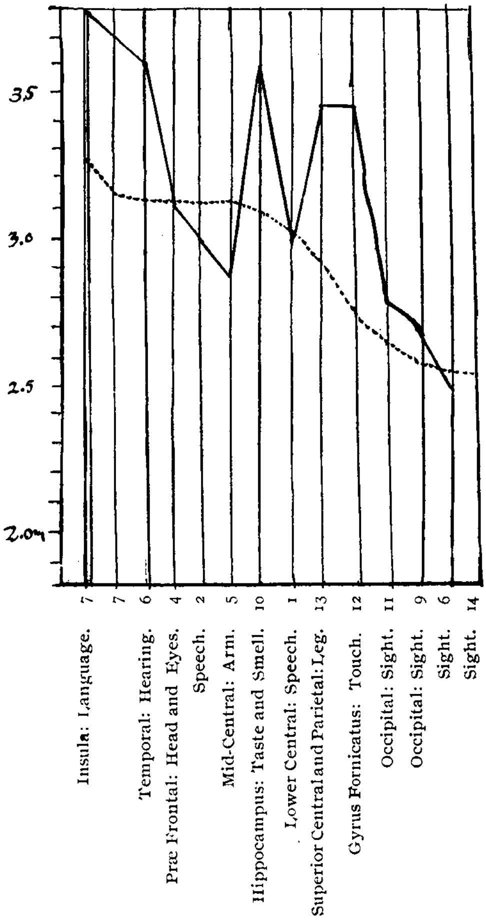
Island of Reil		3.80
It was slightly thicker on the right side.		
Limbic lobe,	average	3.45
Gyrus fornicatus average 3.30	anteriorly	3.23
	middle	3.32
	isthmus	3.36
Hippocampus		3.60
Temporal lobe (superior part)	average	3.30
posterior part first temporal		3.53
tip of temporal		4.80
Central convolutions	average	3.10
upper third		3.40 to 3.45
middle		2.85 to 2.80
lower		2.96 to 2.60
Occipital lobe	average	2.62
	convexity	2.75
	cuneus	2.40
	tip	1.50
	angular gyrus	2.65
Parietal lobe	average	2.60
	superior lobule	2.60
	inferior lobule	2.60
Prae-frontal lobe	average	2.45
(The measurements were well forward).		
Broca's convolution		3.00
sub-frontal		2.70
mid-frontal		2.30

In the order of thickness of gray matter, the lobes stand as follows:

1.	Insula	language centre	3.80
2.	Hippocampus	smell and taste	3.60
3.	Temporal	hearing and verbal memory	3.30
4.	Central convolutions	sensory-motor	3.10
5.	Occipital lobe	vision and visual memories	2.62
6.	Parietal lobe	co-ordination and dermal sense	2.60
7.	Praefrontal lobe	attention, volition and higher intellectual powers	2.45

CHART SHOWING THE RELATION OF THE THICKNESS OF CORTEX IN INDIAN BRAIN TO THAT IN NORMAL BRAIN.

Dotted line = normal.
Heavy line = Indian.



I append a chart which indicates the relative thickness of the different areas as compared with each other and with those of normal brains.

The normal line is that determined by Donaldson. There may be some errors due to my not understanding exactly where Dr. Donaldson places all his speech centres. I have conformed the chart to the hypothesis that the cutaneous sensations have their representation in the gyrus fornicatus, a theory which I believe to be incorrect.

The sharp changes in any curve are due to the fact that the measurements of the lower central convolutions were small, while those of the gyrus fornicatus and hippocampus were large. As regards the temporal and occipital lobes, our measurements relatively are not widely apart.

In conclusion, I cannot say that there is any single anomaly in this brain which may be considered peculiar, or which positively stamps it as of special type. Still I would emphasize the facts of the relatively large occipital lobe, the hind brain, the small frontal lobe and cerebellum, the transverse fissuration, the wide angle made by the Rolandic fissures, the numerous short clefts, the long, confluent first temporal, the confluence of the parieto-occipital and temporal, the short opercula and consequent exposed Island of Reil. The corpus callosum, considering the size of the brain, is relatively small. The limbric lobe, the temporal lobe and the motor area are liberally developed. The distribution of gray matter shows a rich endowment of the senses of taste, smell and hearing, but a poor supply for visual, and intellectual language centers.

One concludes that the brain was a better motor and sensory than thinking and talking organ, that the organs of taste and smell were large, and that visualization and the intellectual powers were small.